

Amendments to the Specification

At page 1 before the "Technical Field" section, please insert the following:

--RELATED PATENT DATA

This patent resulted from a continuation application of U.S. Patent Application Serial No. 09/798,806, filed March 2, 2001, entitled "Method for Removing Organic Material From a Substrate and for Oxidizing Oxidizable Material Thereon", naming Terry L. Gilton as inventor, the disclosure of which is incorporated by reference.--

Please amend the paragraph beginning at line 12 on page 1 as follows:

The fabrication of integrated circuits ~~typical~~ typically uses a number of photolithographic steps to impart a pattern on a semiconductive substrate or wafer. For example, where a layer of material, such as polycrystalline silicon or aluminum, is formed over the wafer, a layer of an organic material such as a photoresist, is subsequently formed over the material. The photoresist is then selectively exposed to an energy source and then processed to provide a pattern that is representative of the selective exposure. Thus some portions of the material underlying the photoresist remain covered while other portions are exposed. Once such a pattern is formed in the photoresist, a subsequent process is employed to replicate that pattern in the underlying material. For example, polycrystalline silicon and aluminum can be patterned using a plasma etching process that removes the exposed portions of such material, thus replicating the pattern. Once this etching process is completed, generally the photoresist is removed prior to any subsequent processing step.

Please amend the paragraph beginning at line 8 on page 4 as follows:

In some embodiments in accordance with the present invention, a substrate is contacted with a solution of ozone, water and a surfactant. In some such embodiments, exemplary surfactants are generally non-ionic. In some embodiments, the contacting is provided by an apparatus configured, for example, to spray the solution of ozone, water and surfactant onto a major surface of the substrate, although other methods for contacting are also appropriately employed. In some embodiments, the spraying apparatus is configured to spray the substrate with the solution for a first time period and subsequently stop spraying for a second time period and then subsequently repeat the spraying and not spraying for a number of such spraying and not spraying ~~cycles~~ cycles, such number of cycles providing a third time period of spraying, a fourth time period of not spraying and so on. Such embodiments of the present invention are effective for the removal of organic material from the substrate, the oxidation of exposed oxidizable materials of or on the substrate or both of the removal and the oxidation.

Please amend the paragraph beginning at line 15 on page 9 as follows:

It has also been found that some ionic surfactants can be advantageously employed for embodiments in accordance with the present invention. For example, Surfynol CT-141 is an anionic material generally employed as a dispersant for pigments. However, such material is also found effective for reducing surface tension and making a normally hydrophobic organic material more wettable. It has also been found that various quaternary ammonium chloride surfactants provide advantageous results in some embodiments of the present invention. Such quaternary ammonium chloride materials ~~having~~ have the general formula  $R_4NCl$ , where R is an organic substituent. Thus, the specific composition of the surfactant selected is less a function of its chemical structure than its specific performance as evaluated, in part, using the previously mentioned guidelines. It necessarily follows then that any material that meets such suggested guidelines, regardless of its chemical composition, is within the scope and spirit of the present invention. ~~Further more, Furthermore,~~ it will be understood that the specific concentration of surfactant is a function of, in significant part, its ability to wet the surface of a specific hydrophobic material, and thus must be determined

for each surfactant and material combination. However, concentrations in the range of about 1 ppm to 200 ppm, and more specifically 1 ppm to 20 ppm have been found effective.

Please amend the paragraph beginning at line 13 on page 10 as follows:

It will of course be understood that ~~providing~~<sup>3</sup> providing the solution also encompasses incorporating ozone into a water/surfactant solution effective for its purpose. While ozone is not extremely soluble in water, it has advantageously been found that concentrations of ozone in the aqueous solution that are in the range of between about 1 to 100 ppm can be obtained. In some embodiments in accordance with the present invention, such concentrations are obtained by ~~providing~~<sup>3</sup> providing the water/surfactant solution into a chamber having an atmosphere with a concentration of ozone in excess of the concentration in the solution. For example, where the concentration of ozone in the solution is 10 ppm, an atmosphere with a concentration of just in excess of 10 ppm to as much as 5% or more, can be employed. In addition, some embodiments encompass ~~providing~~<sup>20</sup> providing the solution in a chamber pressurized to above normal atmospheric pressure with ozone to enhance the solubility of the ozone in the water/surfactant solution. For example, in some embodiments, the process chamber is pressurized with ozone to a total pressure of approximately twice atmospheric pressure. Other methods of incorporating ozone into the water/surfactant

solution in concentrations of between 1 ppm to 100 ppm, such as reducing the temperature of the provided aqueous solution prior to introduction into a process chamber are also effective. However it is found that reduced temperatures in general reduce the rate of organic material removal, thus such solutions are either heated prior to use or a combination of an appropriately high concentration of ozone and temperature is selected to be effective for removing organic material the lower temperature employed to dissolve the ozone. Therefore, it will be understood, that in some embodiments of the present invention, the solution is initially provided with a first concentration of ozone which becomes a second concentration, for example by the action of the highly concentrated ozone atmosphere of the chamber or other appropriate cause.

Please amend the paragraph beginning at line 20 of page 11 as follows:

As depicted in Fig. 1, spraying process 1 also encompasses a begin solution spray 5 and an end solution spray 7. ~~Thus~~ Thus, an apparatus is provided that begins spraying 5 of the provided solution 3 onto a substrate for a first period of time, where generally such spraying is focused on a major surface of the substrate or wafer. At the end of the first period, the solution spray is ended 7 and no further spraying occurs for a second period of time. Whether or not the removal of organic material present on the substrate is complete 9, is decided and, if not, begin solution spray 5 and end solution spray 7 are typically repeated. After each repeat cycle of begin 5 and end 7, whether or not the removal of the material is complete 9, is again decided and generally, when a material removed status is obtained, spraying process 1 is ended. One such apparatus for providing spraying process 1 is described in commonly assigned, pending U.S. Patent Application No. 09/386,247, entitled "Delivery of Dissolved Ozone," filed on August 30, 1999, and which is incorporated by reference herein.

Please amend the paragraph beginning at line 6 on page 13 as follows:

For example, Fig. 2, a slightly modified version of Fig. 2 from the referenced application, describes an embodiment of a shower system 15 having a process chamber 20 with a process chamber lid 25, a full chamber 30 and a short chamber 35. A pump 40 is employed to pump the provided solution 3 from full chamber 30 to a heater 45, where heater 45 is can raise the temperature of the solution to a desired temperature. Once heated to that temperature, the provided solution 3 is filtered at filter apparatus 55 and supplied to a first valve 60. As depicted, first valve 60 allows for the filtered solution to pass either directly to chamber lid 25 and/or to short chamber 35. Where the provided solution 3 is directed to lid 25, such solution 3 is sprayed onto one or more substrates through spraying devices such as nozzles, for example see nozzles 75 in Fig. 3 of the referenced application, Where referenced application. Where such solution 3 is directed to chamber 35, such chamber 35 is filled and overflows into full chamber 30 in a manner analogous to a cascade bath rinse.

Please amend the paragraph beginning at line 23 on page 16 as follows:

The specific conditions provided in the above exemplary ~~result is are~~ result are provided for illustrative purpose only and that other specific conditions can be advantageously employed. It will be understood that at temperatures lower than the 65 C employed above, a higher concentration of ozone than 10 ppm would most likely be needed to achieve an equivalent removal rate, and at higher temperatures than the 65 C, a lower concentration of ozone most likely can be used. Therefore these alternate temperatures and ozone concentrations are within the scope and spirit of the invention. Thus it will be understood that embodiments in accordance with the present invention can encompass a wide range of ozone concentrations such as where a specific concentration selected will be a function of the temperature employed, as well as the desired rate of organic material removal, among other things. Furthermore, such decisions as to specific temperatures, surfactant material and concentration, ozone concentration and the timing of the duty cycle of the spraying are choices that one of ordinary skill in the art can make from the teachings herein, without undue experimentation.

Please amend the paragraph beginning at line 17 on page 17 as follows:

Referring now to Fig. 3, another embodiment in accordance with the present invention is depicted. Substrate contacting process 100 encompasses a solution providing 3 step essentially equivalent to that described above. However, rather than spraying the substrates with such a solution, process 100 immerses substrates in the solution. Such immersing embodiments of the present invention are advantageously possible due to more aggressive nature of solution provided 3 with such embodiments of the present invention. That is to say ~~aqueous solutions provided 3, that say, the provided aqueous solution~~ encompasses a concentration of surfactant as well as ozone. Thus, as depicted, contacting solution 110 encompasses immersing the substrate in a bath or tank containing the solution for a first time period and subsequently removing the substrate from the solution for a second time period. The immersing and removing is generally repeated a number of times for the same or varying time periods until the organic material is removed in a manner analogous to that described above for the spraying.

Please amend the paragraph beginning at line 20 on page 18 as follows:

As mentioned above, embodiments in accordance with the present invention also encompass forming an oxide layer, generally a self-limiting oxide layer, over the substrate. Advantageously, the processing for removing organic material from substrates is generally effective for forming such an oxide layer. However, it will be noted that such formation is enhanced by the presence of the surfactant, as compared to processes without surfactant. For example, referring now to Fig. 4, a cross-sectional view of an exemplary portion of a semiconductor device is shown. Depicted is a substrate portion 200, for example a silicon substrate, overlaid by portions of a first layer 210, for example silicon oxide, and a second layer 220, for example polysilicon, such that an opening 230 is exposing a surface portion 240 of the substrate 200. Since both the exposed surface 240 and the polysilicon layer 220 are hydrophobic, and the silicon oxide is hydrophilic, and where opening 230 is small, surface 240 may not typically be wetted by an aqueous solution. Therefore, where it is desirable to form a oxide an oxide layer over surface 240, the presence of a surfactant in the solutions of embodiments in accordance with the present invention, better provides for the wetting of a

surface such as surface 240. Thus, where surface 240 is wetted, the ozone present in such a solution can provide for the formation of the oxide layer thereon.

Please amend the paragraph beginning at line 18 on page 19 as follows:

Furthermore, it will be understood, that such self-limiting oxide formation is not limited only to forming oxide layers in combination with the removal of organic material such as photoresist, as is a general practice. Rather, embodiments of the present invention can be employed to form such oxide layers as an independent process whenever such layers are deemed desirable. Also, it will be understood that the formation of self-limiting oxide layers is not limited to the forming of silicon oxide layers. Rather, such self-limiting oxide formation includes the formation of any of the generally self-limiting metal oxides, such as aluminum oxide or the generally self-limiting oxide of ~~any other semiconductive material~~ any semiconductive material.

Please amend the paragraph beginning at line 5 on page 20 as follows:

It will be understood that the methods of contacting the substrate described herein, spraying and immersing, are described for exemplary purposes and to enable a clear understanding of the instant invention only. Thus such exemplary descriptions do not exclude other methods of contacting the substrate, for example brushing the substrate with a device for bushing, which are also within the scope and spirit of the instant invention. Similarly, embodiments of the present invention are described where a solution of ozone and water is described provided, the water portion further described as comprising a concentration of a surfactant. It will be understood that such descriptive language is not meant to imply any specific required order of mixing water, ozone and a surfactant, and that embodiments in accordance with the present invention encompass any order of mixing that is appropriate.